

Blackfoot River and Tributaries Monitoring Report 2002



Developed for:

**Caribou Soil Conservation District
North Bingham Soil Conservation District
Idaho Soil Conservation Commission
Idaho State Department of Agriculture**

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Technical Results Summary CFF-Blkft-02



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Executive Summary

The Blackfoot River, HUC #17040207, is a tributary of the Snake River. It drains approximately 700,000 acres before the confluence with the Snake River south of Blackfoot, Idaho. Several tributaries are listed on the state of Idaho's §303(d) list for having water quality limited segments. The Environmental Protection Agency is currently reviewing a Total Maximum Daily Load for the Blackfoot River, prepared by the Idaho Department of Environmental Quality.

Idaho Association of Soil Conservation Districts began water quality monitoring on the Blackfoot system on July 13, 2000. The data included in this report goes through June 19, 2002. Sampling was performed on twelve sites. Eight of the sites were wadable and monitored twice a month, April through October, then monthly November through March. These sites were located primarily on tributaries to the Blackfoot River, with one site (BR1) located on the river, below the confluence with Lanes and Diamond creeks that form the Blackfoot River. The other seven wadable sites are located on Wolverine, Brush, Rawlins, Corral, Slug, Angus and Diamond creeks.

Four monitoring sites are located on the Blackfoot River, below the Blackfoot Reservoir. These sites are sampled from bridges, due to the depth and velocity of the water. Water quality collection and discharge measurements were made using bridge-board equipment. These four sites were monitored once a month from September 2000 through October 2001. All monitoring sites were monitored for total suspended solids, total volatile solids, total phosphorus, ortho-phosphorus, nitrate + nitrite and *Escherichia coli* bacteria. Dissolved oxygen, water temperature, specific conductance, total dissolved solids, pH and stream flow were measured in the field.

Sediment and nutrient concentrations appear to increase in the subbasin during spring runoff and precipitation events. Total phosphorus tends to move with total suspended solids during spring runoff, rain and snow events. Nitrate + nitrite appears to have high concentrations during the winter months and during snow melt. Cattle tend to be an acute problem on some tributaries. Total suspended solids, total phosphorus concentrations and *E. coli* counts tend to increase when cattle were in or along the stream above the monitoring site.

For the bridge board sites, Reservation Canal, which diverts Snake River water, enters the Blackfoot River between the two lowest bridges, Rich Lane and Little Indian. The canal seems to contribute increased concentrations of total suspended solid and total phosphorus when diverted into the Blackfoot River.

Recommendations for the Blackfoot River Subbasin to improve water quality would be to develop water facilities for livestock off the river and creeks. This would decrease sediment, nutrients and bacteria in to the water and improve the riparian health of the stream. The river below the reservoir could decrease sediment and phosphorus concentrations if water, when first introduced into the Reservation Canal, could be ramped up slowly.

Introduction

The Idaho Association of Soil Conservation Districts (IASCD) monitored several tributaries and the Blackfoot River located in the Blackfoot River Subbasin from July 2000 through June 2002. The project was to provide water quality data on agricultural and rangeland areas based on information from the Blackfoot River Total Maximum Daily Load (TMDL). The data will be used to plan implementation of voluntary agricultural best management practices (BMP) throughout the Blackfoot Subbasin. IASCD has worked cooperatively with Idaho State Department of Agriculture (ISDA), Idaho Soil Conservation Commission (ISCC), Caribou and North Bingham Soil Conservation Districts (SCD) and Natural Resources Conservation Service (NRCS). Many of the streams monitored are listed on the state of Idaho's §303(d) list for having water quality limited segments.

Subbasin Description

The Blackfoot River, hydrologic unit code (HUC) #17040207, is located in eastern Idaho and is a tributary to the Snake River. The Blackfoot River Subbasin, shown in Figure 1, flows for approximately 130 miles and drains about 700,000 acres before entering the Snake River (IDEQ, 2001). The river originates from several tributaries that flow from the southeast corner of the HUC, in Caribou County. Most of these tributaries originate in U.S. Forest Service ground then flow through portions of Bureau of Land Management (BLM), State of Idaho and private lands. Lanes and Diamond creeks flow together to form the Blackfoot River. The Blackfoot Reservoir is located on the river and is operated by the U.S. Bureau of Indian Affairs. Downstream of the reservoir, the river enters Bingham County. Approximately twenty river miles from entering Bingham County, the river forms the boundary line between the county and the Fort Hall Indian Reservation. It remains the boundary as the river skirts around the south end of the City of Blackfoot until it flows into the Snake River.

Land use in the subbasin is agricultural, range, forest and mining lands. Half the area is used as range land, while the major crops include wheat, barley, potatoes and hay (IDEQ, 2001). Landowners include BLM, Fort Hall Indian Reservation, State of Idaho, Caribou National Forest and private. Approximately 36% of the subbasin is privately owned.

The river is managed through a large reservoir and several canals. The reservoir does not allow the downstream portion of the river to flood. Water taken out of the river and tributaries for irrigation reduces flow in the river. Water is also transferred into the subbasin from the Snake River (IDEQ, 2001).

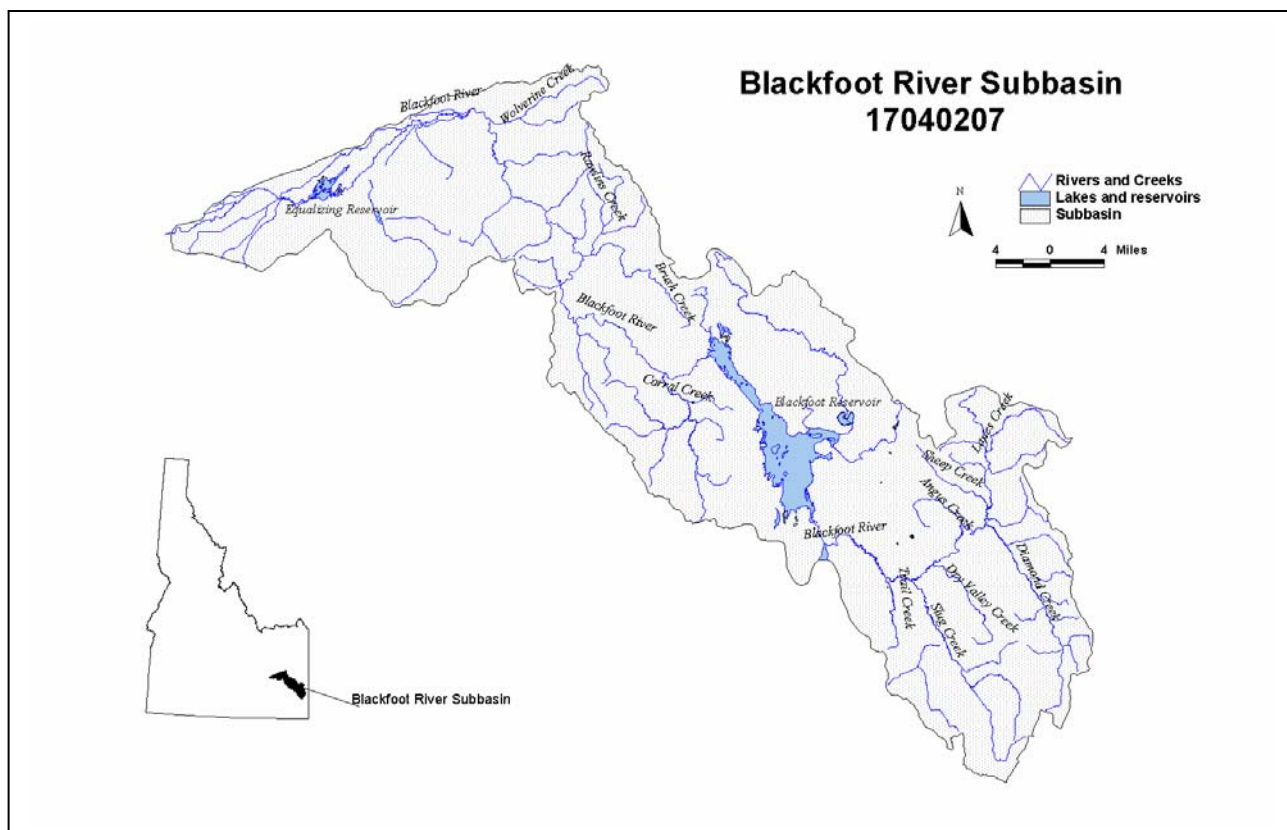


Figure 1. The Blackfoot River Subbasin

The Blackfoot River TMDL

The Blackfoot River TMDL has been written by the Idaho Department of Environmental Quality (IDEQ). It is currently being reviewed by the Environmental Protection Agency (EPA) for approval. There are 17 water quality limited segments located in the Blackfoot Subbasin. The river is divided into three segments and is listed for sediment, nutrients, organics and flow alteration (IDEQ, 2001). The tributaries to the river that have water quality limited segments include Wolverine, Corral, Meadow, Trail, Slug, Angus, Dry Valley, Diamond, Bacon, Lanes, Sheep, Brush, Grizzly and Maybe creeks. The pollutants of concern for Brush, Grizzly and Maybe creeks are unknown. The other 11 tributaries are all listed for sediment as the pollutant of concern. Wolverine Creek, in addition to being listed for sediment, is listed for nutrients.

The beneficial uses for the subbasin are cold water biota, secondary contact recreation and agricultural water supply (IDEQ, 2001). The river has primary contact recreation and salmonid spawning listed as additional beneficial uses. Wolverine, Rawlins, Meadow, Angus, Lanes, Bacon, Diamond, Timothy and Kendall creeks have salmonid spawning as a beneficial use.

IDEQ has proposed TMDL targets for sediment, total inorganic nitrogen (TIN) and total phosphorus (TP) on the Blackfoot River (Table 1). Flow alteration, which is listed as a

pollutant of concern, will not have a TMDL developed because there is no Idaho water quality standard for flow (IDEQ, 2001).

Table 1. Pollutant targets for 303(d) listed segments in the Blackfoot River TMDL.

Pollutant of Concern	Proposed Pollutant Targets for Blackfoot TMDL
Total Suspended Solids	Not to exceed 80 mg/L during high flow Not to exceed 50 mg/L during low flow
Total Nitrate + Nitrite	Not to exceed 0.30 mg/L
Total Phosphorus	Not to exceed 0.10 mg/L
<i>Escherichia coli</i>	406 cfu/100 mL of sample primary contact recreation 576 cfu/100 mL of sample secondary contact recreation

IDEQ's proposed sediment target is being determined by three criteria; turbidity, streambank stability and percent depth of fines. In the IDEQ *Addendum to Blackfoot River TMDL: Waterbody Assessment and Total Maximum Daily Load* for Dry Valley Creek "the suspended sediment equivalent to the target turbidities are within or below the range 25 to 80 mg/L of suspended solids required to maintain good to moderate fisheries." This information was gathered by IDEQ from the European Inland Fisheries Advisory Commission. Other TMDLs have placed numeric targets on suspended solids. The Portneuf River TMDL (IDEQ, 1999) used the targets of 50 mg/L during low flow conditions and 80 mg/L during high flow conditions. A study prepared by CH2M HILL for the Lower Boise River TMDL (Miller, 1998) summarized results, conclusions and findings of published and unpublished studies to aid in selecting an appropriate target for total suspended sediment. According to their findings, a target of 50mg/L is "intended to be protective against the ill effects attributable to a 60-day chronic total suspended sediment exposure; whereas, the 80 mg/L target is to be protective against a 14-day acute total suspended sediment exposure." Based on the research, Miller recommended a total suspended sediment limit of 50 to 80 mg/L. IASCD measures sediment through total suspended solids (TSS) and will therefore use 50 mg/L during low flow conditions and 80 mg/L during high flow conditions for the Blackfoot TMDL target.

The proposed target for TIN is 0.30 mg/L (IDEQ, 2001). TIN includes nitrate + nitrite and ammonia. IASCD did not test for ammonia but will still use the 0.30 mg/L target for nitrate + nitrite (NO₃+NO₂). The proposed target for TP is based on the EPA Gold Book Criteria (USEPA, 1987) of 0.10 mg/L for streams or flowing waters not discharging directly into lakes and reservoirs. The State of Idaho standard set for *Escherichia coli* (*E. coli*) is 406 colony forming units (cfu) per 100 mL of sample for primary contact recreation (PCR) and 576 cfu per 100 mL of sample for secondary contact recreation (SCR).

Monitoring Site Locations

Eight monitoring sites were selected throughout the subbasin to monitor, beginning July 2000. These eight sites were located in streams that were wadable for sampling. Four additional monitoring sites were added to the Blackfoot River in September 2000 to evaluate any impacts the Blackfoot Reservoir may have on the river downstream. These sites were located on the river and were not wadable. Bridge board sampling took place on these sites from four bridges. The 12 monitoring sites are listed in Table 2 and a site map is shown in Figure 2.

Table 2. Monitoring sites throughout the Blackfoot River Subbasin.

Wadable Sites		Bridge Board Sites	
Site ID	Site Name	Site ID	Bridge Name
WC1	Wolverine Creek	Rich	Rich Lane Bridge
BrC1	Brush Creek	L. Indian	Little Indian Bridge
RC1	Rawlins Creek	Morgan	Morgan's Crossing Bridge
CC1	Corral Creek	Govt	Government Dam Bridge
SC1	Slug Creek		
AC1	Angus Creek		
BR1	Blackfoot River		
DC1	Diamond Creek		

The Wolverine Creek site is located directly below the Blackfoot River Road. Brush and Rawlins Creek sites are located on Rawlins Creek Road. Brush Creek is sampled before the confluence with Rawlins Creek, and Rawlins is monitored before the confluence with Brush Creek. Corral Creek is monitored directly upstream from where the Lower Blackfoot River Road crosses it. Slug Creek is monitored approximately six miles above the confluence with the river. Angus Creek is monitored on Idaho Department of Fish and Game (IDFG) property above the Upper Blackfoot River Road. The Blackfoot River monitoring site is located on IDFG property at the fishing access on the Diamond Creek Road. The Diamond Creek monitoring site is located on Caribou National Forest at Campbell Canyon Road.

The bridge board sites are located on four bridges that cross the Blackfoot River below the reservoir. The lowest site is located on Rich Lane Bridge. The next bridge is located on Little Indian Road. The Reservation Canal enters the river between these two bridges bringing in water from the Snake River. The next bridge is located at Morgan's Crossing and the uppermost bridge is located directly below the dam at Government Dam Road.

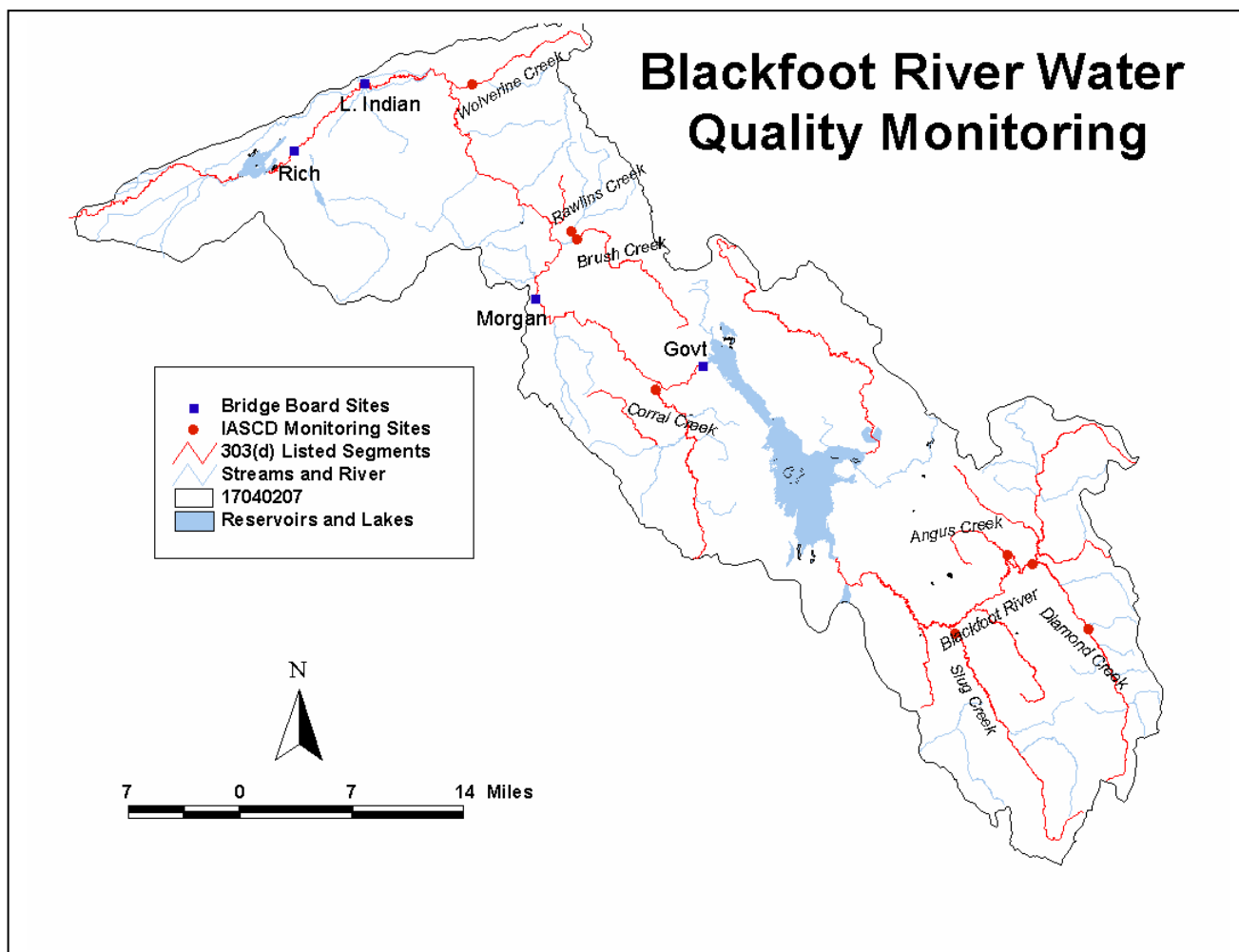


Figure 2. Monitoring Site Locations

Project Objectives

The projects scope of work was discussed and approved by representatives of Caribou and North Bingham SCDs, ISDA, ISCC and IDEQ. IASCD worked cooperatively with the above-mentioned groups and agencies in an attempt to complete the following objectives:

- Evaluate the impact of agricultural activities and range land on the Blackfoot River and its tributaries.
- Evaluate the water quality and discharge rates within these tributaries and the Blackfoot River below the reservoir
- Identify areas of concern for implementation of best management practices.
- Use this data to increase public awareness.

Methods

Sampling Schedule and Parameters

Sampling of the tributary creeks started on July 13, 2000. The data included in this report goes through June 19, 2002. Sampling was performed twice a month from April through October and monthly November through March. On all sites, except WC1, samples were not collected December through March due to impassable roads caused by heavy snow. The bridge board sampling was performed once a month from September 2000 through October 2001. The Rich Lane sampling sites was sampled every month, however the other sites were not sampled during the winter months due to inaccessibility.

Samples were collected and field measurements taken for the parameters listed in Table 3. Samples were delivered to the IAS-EnviroChem Laboratory in Pocatello, Idaho within the appropriate holding times.

Sampling Methods

Sample collection techniques followed approved United State Geological Survey (USGS) methods (Shelton, 1994). All analytical testing followed either EPA or Standard Methods for the Examination of Water and Wastewater approved methods. Quality control samples, duplicates and blanks, comprised at least 10% of the sample load during this program. Quality Assurance and Quality Control (QA/QC) results are in Appendix A. Duplicate and blank samples were stored and delivered with the normal sample load for analytical testing. For project tracking, chain-of-custody protocols were followed for all sample handling.

WC1 had a duplicate sample collected during each sampling event. A comparison of the mean and standard deviation for several parameters is shown in Appendix A, Table 6. Results from the calculated relative percent difference (RPD) are also in Appendix A, Table 7.

Table 3. Water Quality Parameters and Field Measurements

Water Quality Parameters	Laboratory Method
Total suspended solids (TSS)	EPA 160.2
Total volatile solids (TVS)	EPA 160.4
Total phosphorus	EPA 365.4
Ortho phosphorus	EPA 365.2
Nitrate	EPA 300
Nitrite	EPA 300
Fecal coliform bacteria	EPA ASTM 909C
<i>Escherichia coli</i> bacteria	EPA 1103.1
Field Measurements	Instrument
Dissolved oxygen	YSI Model 55
Water temperature	YSI Model 55
Conductivity	Orion Model 115
Total dissolved solids	Orion Model 115
PH	Corning 313
Stream flow	Marsh McBirney Flo-Mate Model 2000

Flow Measurements

Flow measurements were collected with a Marsh McBirney Flo-Mate Model 2000 flow meter. The six-tenth-depth method (0.6 of the total depth below water surface) was used when the depth of water was less than or equal to three feet. When the water was over three feet deep, an average of the two-tenth and eight-tenth-depth method (0.2 and 0.8 of the total depth below water surface) was measured. A transect line was set up perpendicular to flow across the width of each creek and the mid-section method for computing cross-sectional area along with the velocity-area method was used for discharge determination. The discharge was computed by summation of the products of the partial areas of the flow cross-sections and the average velocities for each of those sections. For bridge board discharge measurements, the flow meter was attached to a bridge board sounding reel and weight and lowered into the river for a depth reading. The method, six-tenth or two-tenth and eight-tenth-depth methods were determined by the depth of the river.

Water Quality

Samples for water quality analysis were collected by grab sampling directly from the stream on wadable sites and collected using USGS approved bridge boarding equipment on the bridge sites. For shallower sites (<1 ft) grab samples were collected by hand using a clean one-liter stainless steel container. A DH-81 integrated sampler was used at wadable sites with water depths greater than 1 foot. For the bridge board sites, a bridge board with a sounding reel was used on the bridge railing with a DH-95 integrated sampler. For each method, individual samples were collected at equal intervals across the entire width of the stream. Each discrete sample was composited in a 2.5-gallon polyethylene churn sample splitter from which homogenized samples were poured off

into sample containers. Bacteriological samples were collected by hand directly from midstream, or as near as possible, directly into sterile sample bottles. All samples were placed in a cooler of ice and delivered to the laboratory the same day.

Field Measurements

Field measurements for dissolved oxygen, percent saturation and water temperature were taken directly in the streams from well-mixed sections, near mid-stream at approximately mid-depth. Measurements for specific conductance, pH and dissolved solids were taken from the churn splitter composite sample, immediately following collection. Calibration of all field equipment was in accordance with the manufacture specifications. All field measurements were recorded in a bound logbook along with pertinent observations about the site, including weather conditions, flow rates and personnel on site.

Data Handling

The field data and analytical data generated from each survey was reviewed by IASCD and ISDA personnel. Each batch of data was reviewed to insure that all observations, measurements and analytical results have been properly recorded. The analytical results were evaluated for completeness and accuracy. Any suspected errors were investigated and resolved, if possible. The data was then stored electronically and made available to any interested entity.

Results and Discussion

The Blackfoot Reservoir separates the Blackfoot River into two watersheds. The upper river is allowed to flood and maintains snow longer. The lower river is regulated by the dam and flows are lower from October through July, when water from the reservoir is not yet being released for irrigation. The data that will be discussed is broken down into three segments; wadable sites above the reservoir, wadable sites below the reservoir and bridge board samples on the river below the reservoir. The wadable sites above the reservoir are SC1, AC1, DC1 and BR1. The wadable sites below the reservoir are WC1, BrC1, RC1 and CC1.

The data results are based on the pollutants the stream segments are listed for on the IDEQ 1998 §303(d) list. Sediment was measured as TSS and nutrients were measured as NO_3+NO_2 and TP. Bacteria was reported as *E. coli*. The mean concentrations for TSS, NO_3+NO_2 , TP, and discharge (Q) are summarized in Table 4.

Table 4. Mean Values from July 1999 to June 2002 Water Quality Data

Site	TSS mg/L	NO₃+NO₂ mg/L	TP mg/L	Q Cfs	n
WC1	30.3	0.25	0.05	4.00	39
BrC1	20.2	0.15	0.16	2.80	29
RC1	22.5	0.25	0.09	5.42	29
CC1	10.5	0.21	0.10	3.96	28
SC1	32.6	0.12	0.11	0.34	9
AC1	5.95	0.07	0.16	1.60	22
BR1	7.00	0.09	0.03	36.8	26
DC1	6.80	0.19	0.04	0.75	5
Rich	41.8	0.55	0.08*	502	14
L. Indian	27.7	0.18	0.05	325	11
Morgan	12.9	0.23	0.06	400	8
Govt	15.7	0.25	0.09	331	9

*Mean concentration of TP including an outlier. Without the outlier the mean concentration would be 0.06.

Stream Discharge

SC1, DC1 and AC1 have all had extended periods of no discharge. SC1 and AC1 have gone dry during the summer and fall months, DC1 was predominately dry throughout the sampling period. Flow alteration is not being addressed by IDEQ as a TMDL (IDEQ, 2001). IASCD will continue to monitor and document streams that have no flow or are dry.

Total Suspended Solids

Most stream segments, in the subbasin, listed on the state of Idaho 1998 §303(d) list have sediment listed as a pollutant of concern. Since IDEQ does not have a TSS target set for sediment, results for the Blackfoot River data are being compared to targets adapted from other TMDLs (IDEQ, 1999 and Miller, 1998). The TSS target is broken down into two seasons. Based on the USGS gage station on the Blackfoot River at Henry, Idaho, peak flows occur in the months of April, May and June (USGS, Internet). These three months will be termed high flow conditions. The remainder of the water year, July through March, will be termed low flow conditions.

When an average for TSS concentrations for the entire sampling period was calculated (Table 4) none of the sites exceeded 50 mg/L. When the sites were separated into high and low flow conditions (Table 5) only one site, during the high flow period, exceeded 80 mg/L. No sites exceeded 50 mg/L during low flow.

The one exceedance, 85.8 mg/L on the Blackfoot River at Rich Lane Bridge, was the result of the Reservation Canal. The Reservation Canal returns water from the Snake River, Grays Lake and Willow Creek to the Blackfoot River to provide water for

irrigation. The sample collected on 24 April 2001 was taken within 24 hours of the water, from outside the subbasin, being turned into the Reservation Canal and into the Blackfoot River. The initial flush through the canal provided a one-time grab TSS of 185 mg/L at the Rich site. If this number were to be considered an outlier and removed, the average during high flow for Rich would be 52.7 mg/L instead of 85.8 mg/L. This canal is providing the river with excess sediment load when the initial canal water is turned into the river.

Table 5. Mean Total Suspended Solids for the Blackfoot River and Tributaries.

Site ID	Mean Total Suspended Solids	
	High Flow	Low Flow
WC1	39.1	26.4
BrC1	20.4	20.1
RC1	36.7	15.0
CC1	15.1	7.90
SC1	18.5	42.0
AC1	5.20	6.70
BR1	14.1	3.20
DC1	1.50	10.3
Rich	85.8*	23.4
L. Indian	49.0	16.0
Morgan	18.3	9.60
Govt	6.70	20.2

*Mean concentration of TSS including an outlier. Without the outlier the mean concentration would be 52.7.

The most elevated concentrations of TSS, throughout the wadable sites, occurred during the spring runoff. The concentrations for TSS throughout the subbasin can be seen in Figures 3a, 3b and 3c.

There are several cut and eroded banks on the river and on several of its tributaries. Natural processes of stream flow and snow melt has had impact on stream banks in the subbasin. Grazing has impacted the river and tributaries through bank erosion and sloughing. There are a few elevated concentrations of TSS in the wadable sites in late June and early July of both 2000 and 2001. Cattle were grazing along Brush, Rawlins and Corral creeks during this time. However, stream and river banks that are recovering from overgrazing by livestock still may have problems that occur naturally. IDFG fenced out livestock grazing since 1994 on Angus Creek at the AC1 monitoring site (Scully, 2002). The banks here have sloughed off into the creek with no active livestock grazing, but there has been elk grazing along Angus Creek. Even with these streams eroding and sloughing, TSS levels are relatively low in the subbasin.

Other sources of sediment in the creeks could potentially come from roads and recreation. Several roads traveled by IASCD to the monitoring sites are dirt and gravel. These roads cross the river and creeks and could be an additional source of sediment to the subbasin. There is fishing, camping and floating that occurs on the river and tributaries. Human activity could result in sloughing banks and sediment being introduced into the river and creeks.

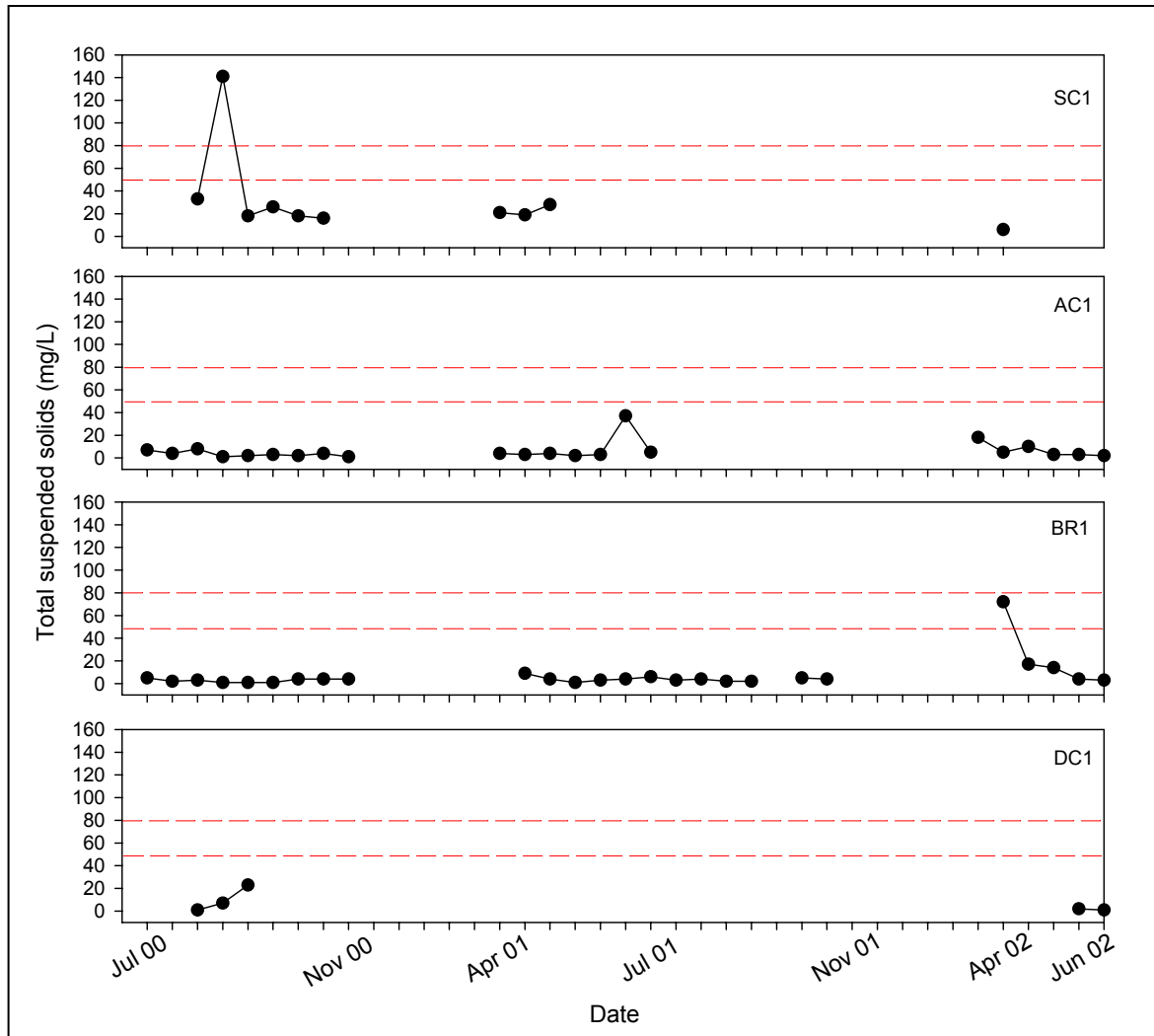


Figure 3a. Total Suspended Solid Concentrations for Wadable Sites above the Blackfoot Reservoir. The red lines indicate the 50 and 80 mg/L targets.

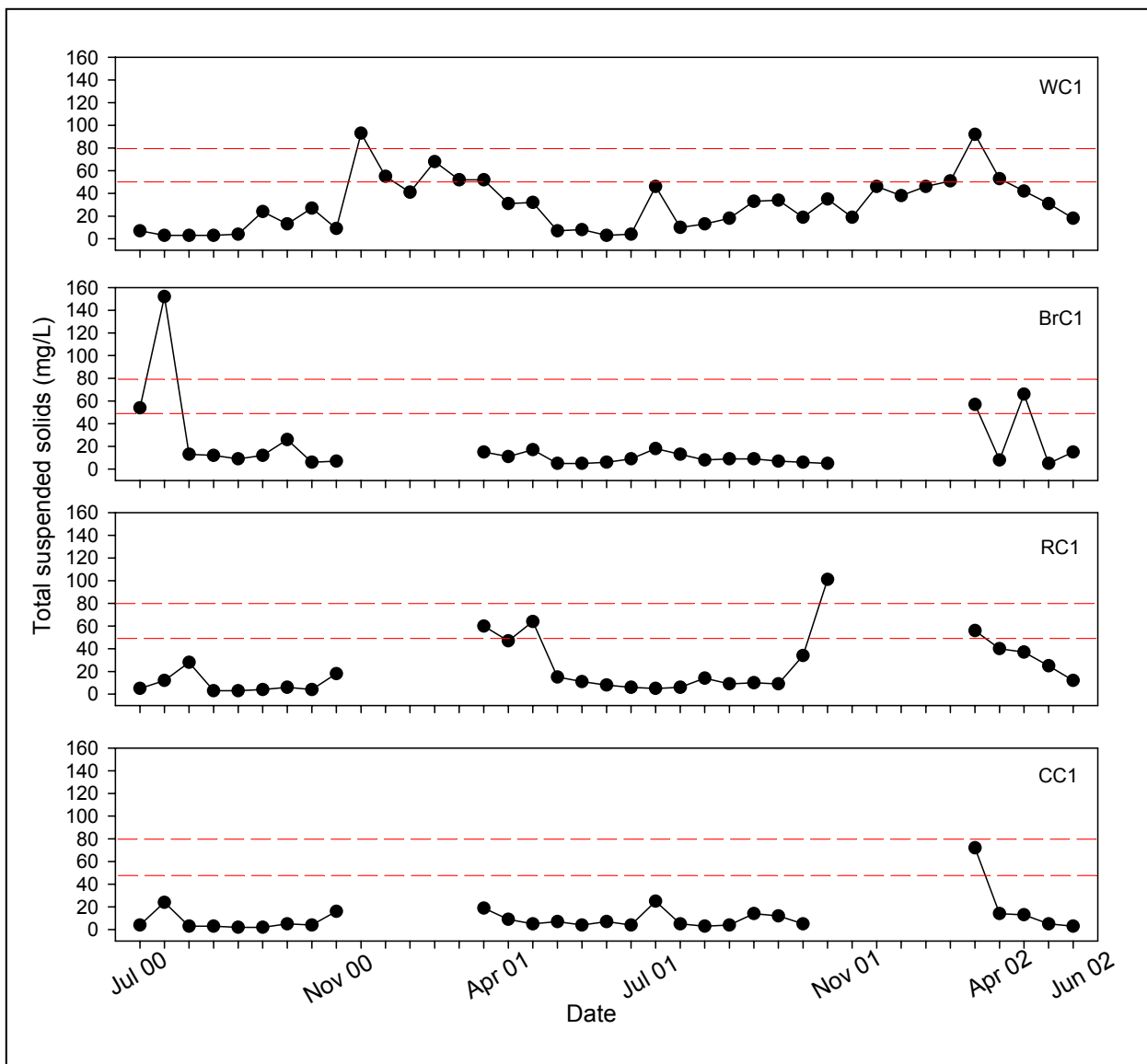


Figure 3b. Total Suspended Solid Concentrations for Wadable Sites below the Blackfoot Reservoir. The red lines indicate the 80 mg/L targets.

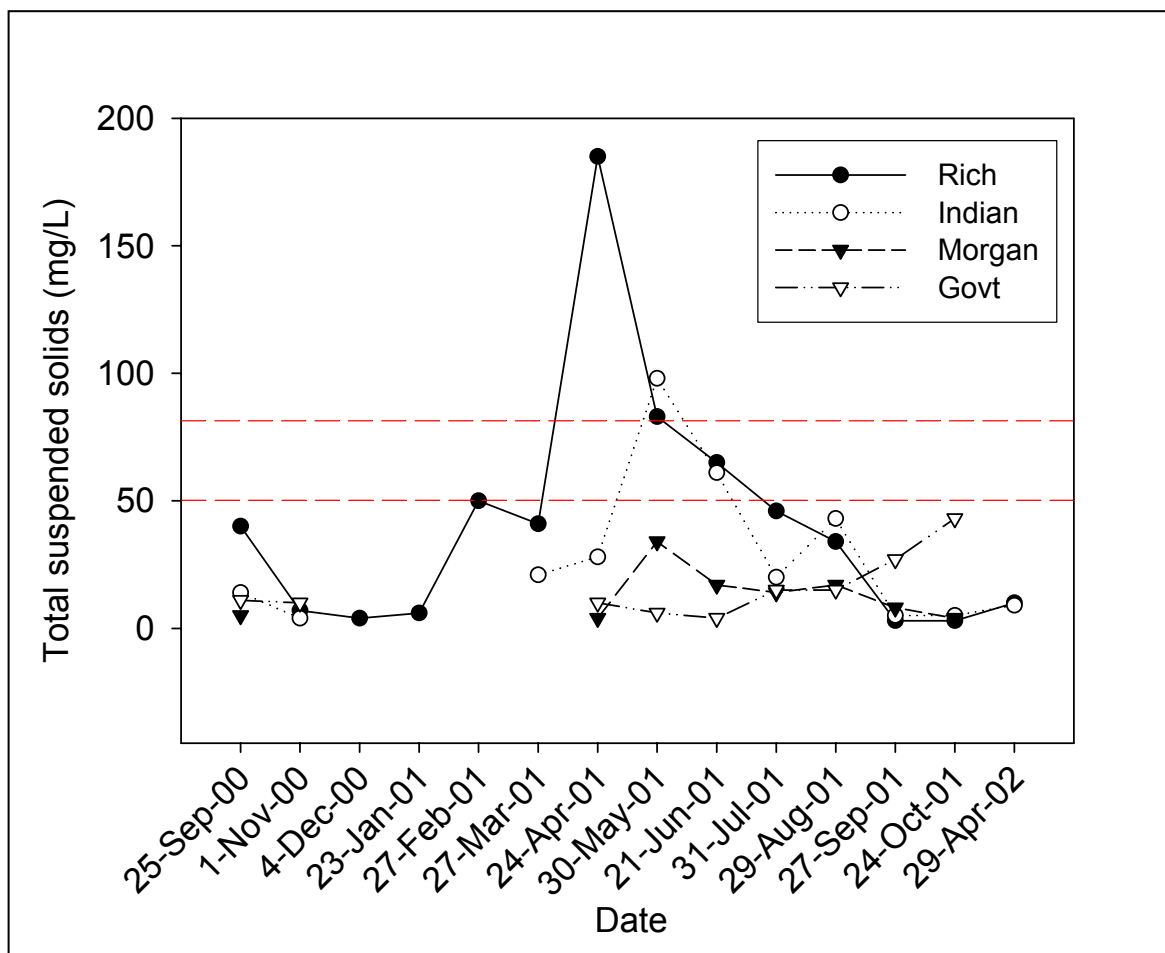


Figure 3c. Total Suspended Solid Concentrations for Blackfoot River Bridge Board Sites. The red lines indicate the 50 and 80 mg/L targets.

Nitrate + Nitrite

Nutrients are listed as a pollutant of concern for only Wolverine Creek (WC1) and the Blackfoot River below the reservoir (IDEQ, 2001). The mean $\text{NO}_3 + \text{NO}_2$ concentration for WC1 is 0.25 mg/L. This is below the TIN target of 0.30 mg/L. None of the wadable sites exceed the target (Table 4). Only one site, Rich Lane Bridge (Rich) on the Blackfoot River, exceeds the 0.30 mg/L target (Table 4).

Directly below the reservoir there is extensive aquatic vegetation. A high concentration of nutrients, such as $\text{NO}_2 + \text{NO}_3$, can cause excess aquatic vegetation. This vegetation can cause dissolved oxygen (DO) concentrations to drop below the state standard of 6.0 mg/L (IDEQ, 2001). Only twice did the DO concentration dip below the standard on the river below the reservoir, at Rich Lane site (Figure 4). Low levels of DO can stress fish and aquatic insects in the river. The lowest DO level occurred on 24 October 2001. This low corresponds with a high concentration of $\text{NO}_2 + \text{NO}_3$ and the highest concentration of TP.

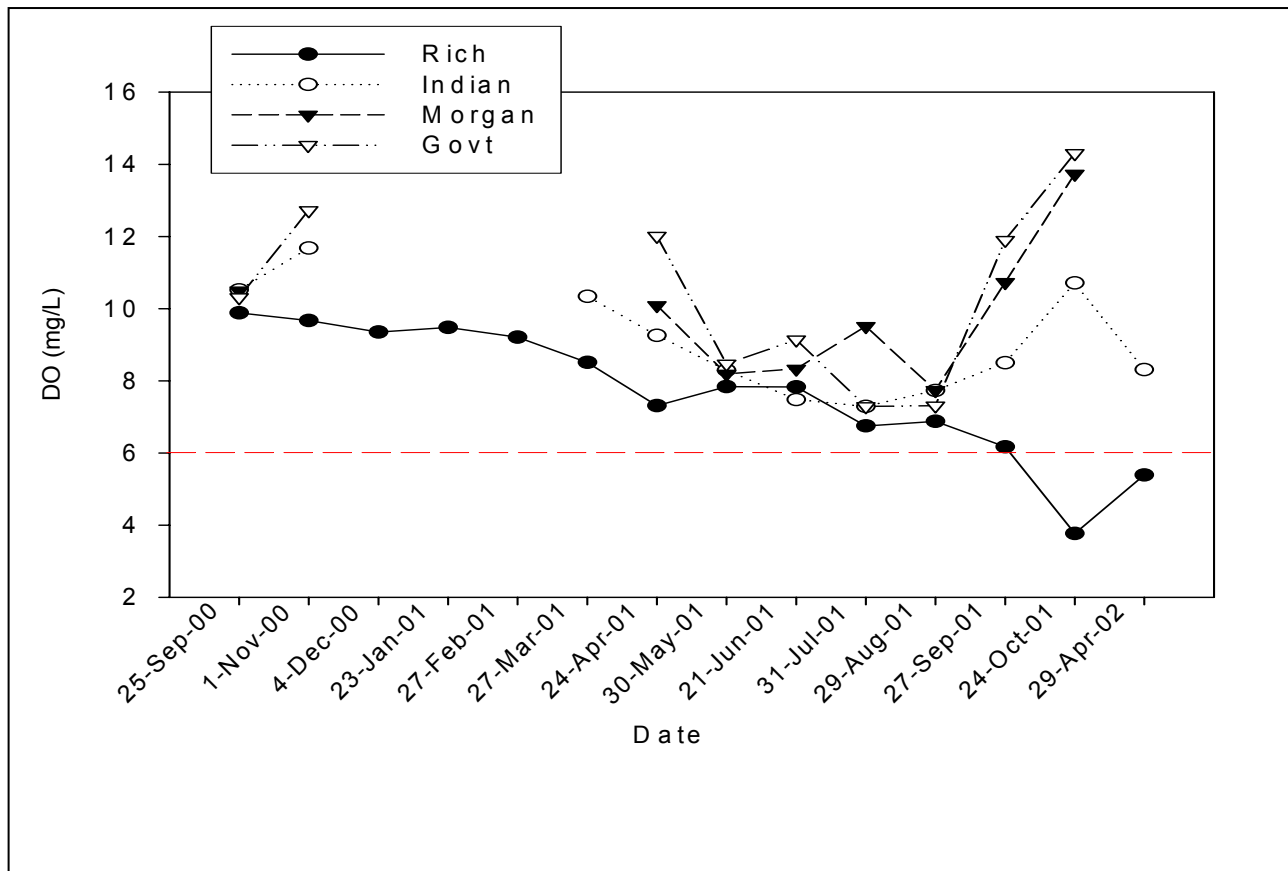


Figure 4. Dissolved Oxygen Concentrations for Blackfoot River Bridge Board Sites. Red line indicates water quality standard of 6.0 mg/L.

The source of nitrogen is difficult to pinpoint. It can come from precipitation that has fallen directly onto the lake surface, fixation in the water and sediments and input from surface and groundwater (Wetzel, 1983). Wetzel also notes that snow, rather than rain, contains a higher content of nitrogen, and could contribute up to half the total influx during a year. On the wadable sites in the subbasin, $\text{NO}_3 + \text{NO}_2$ concentrations increase during the winter months and spring runoff, either directly after the snow has melted or while snow is still present. The bridge board sites have the highest peaks of $\text{NO}_3 + \text{NO}_2$ during the winter, but still has large concentrations throughout the sampling period. These concentrations can be seen in Figures 5a, 5b and 5c.

Ground water could also be a contributor of $\text{NO}_3 + \text{NO}_2$ into the surface water. Many of the tributaries flow from springs. Fertilizer and decomposed manure can filter into the ground water over time, or runoff directly into the river or creeks during a rainstorm or spring runoff. Some plant residue can cause elevated levels of nutrients in the water. During the winter, aquatic plants may decompose elevating the $\text{NO}_3 + \text{NO}_2$ concentrations.

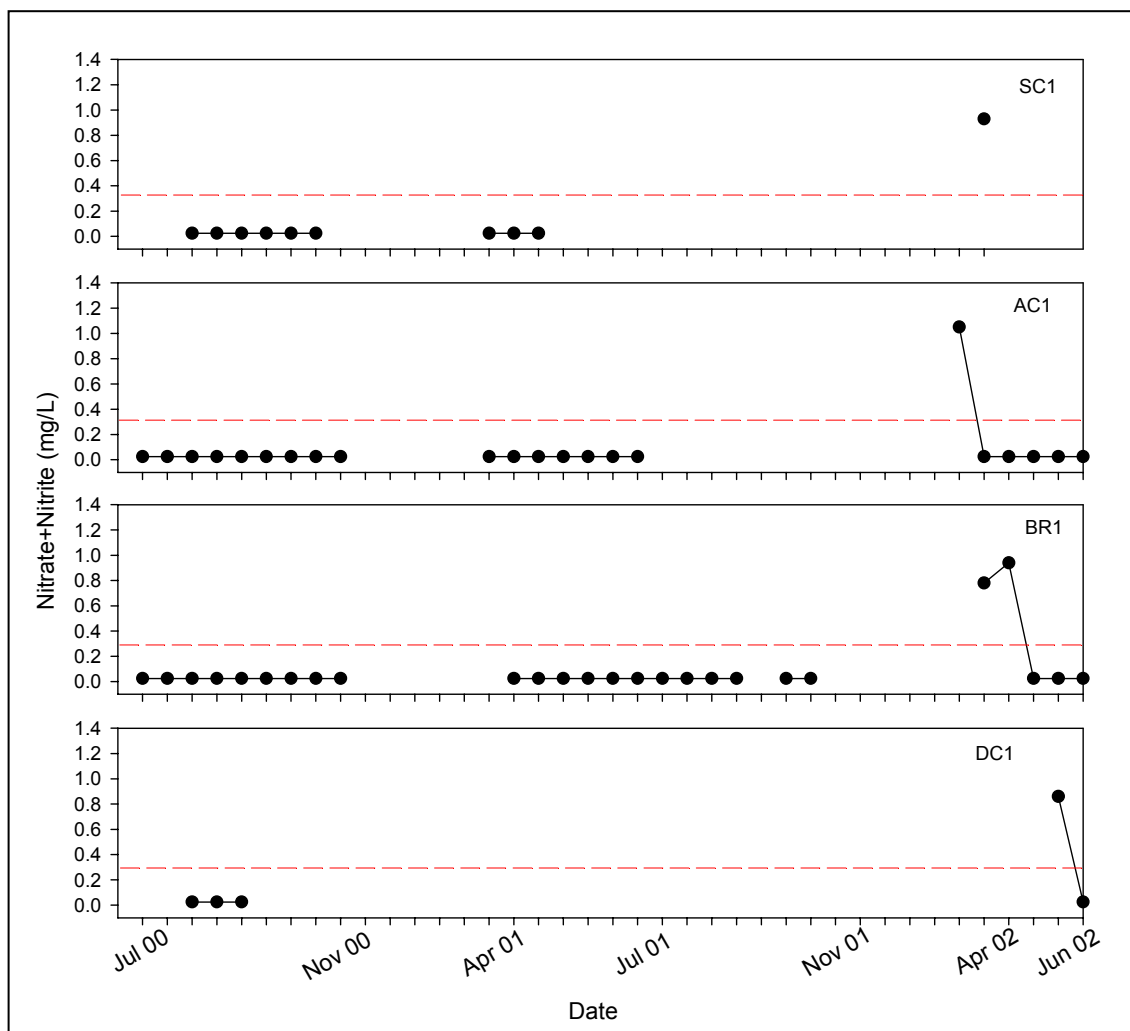


Figure 5a. Nitrate + Nitrite Concentrations for Wadable Sites above the Blackfoot Reservoir. The red line indicates the 0.30 mg/L target.

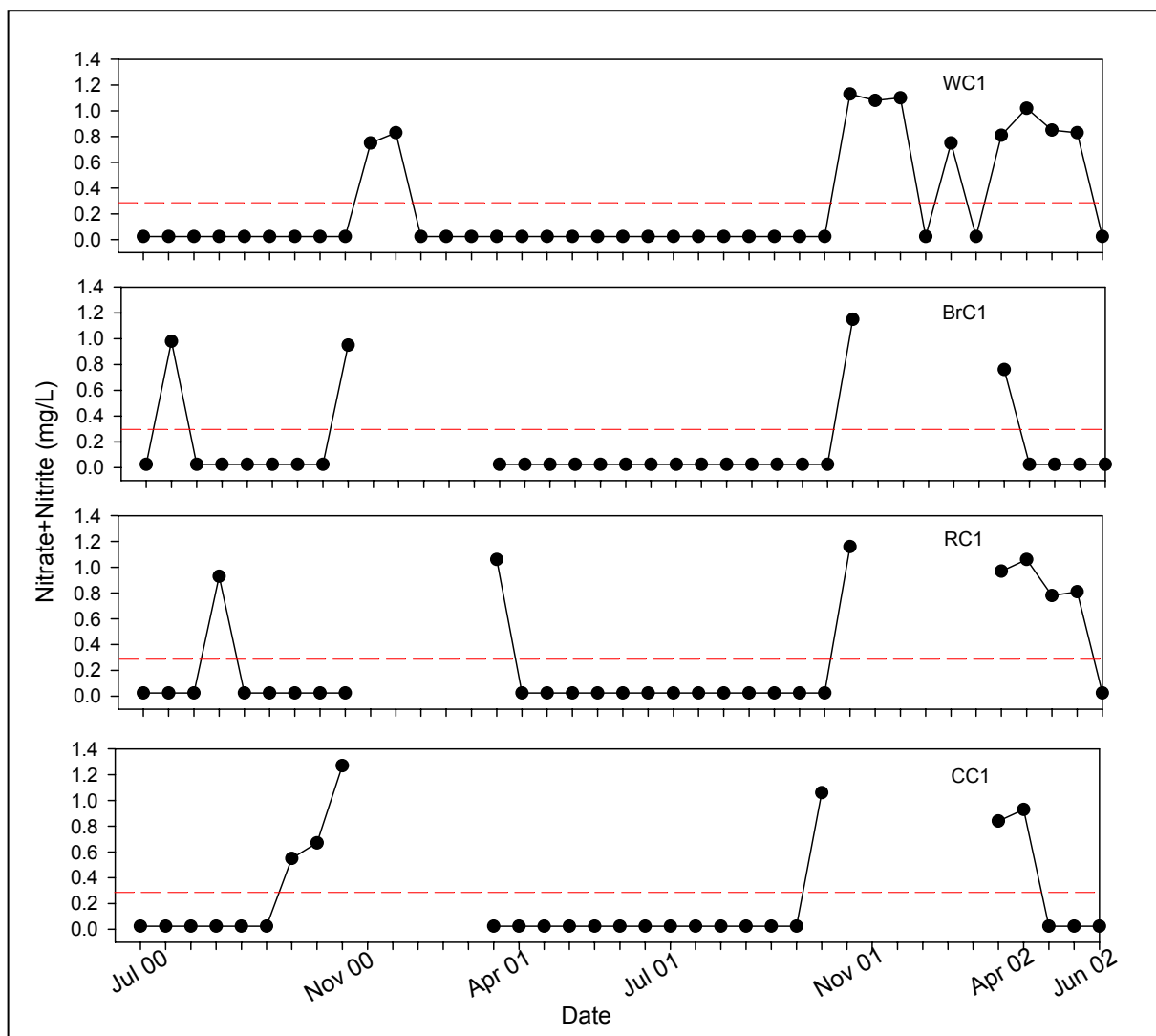


Figure 5b. Nitrate + Nitrite Concentrations for Wadable Sites below the Blackfoot Reservoir. The red line indicates the 0.30 mg/L target.

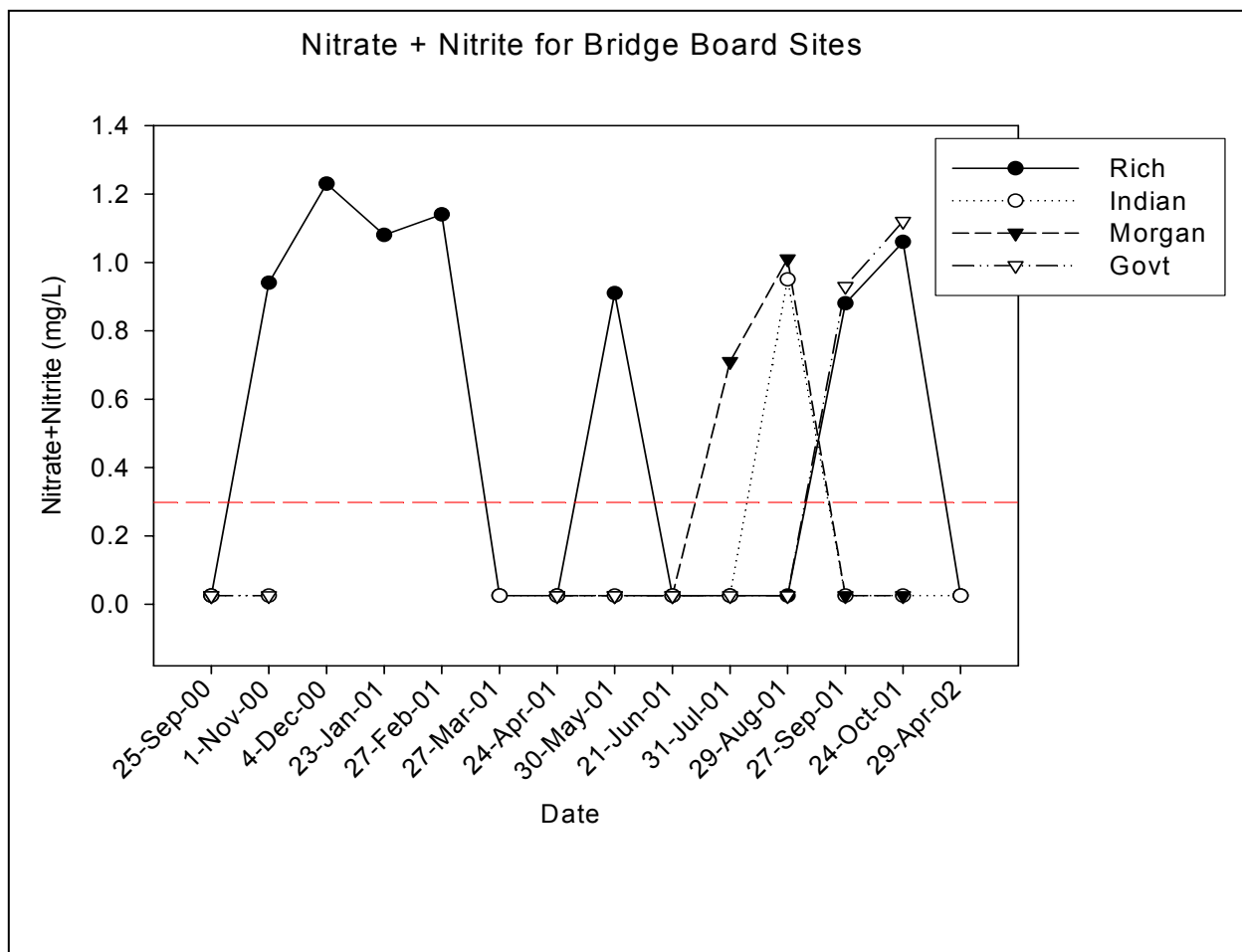


Figure 5c. Nitrate + Nitrite Concentrations for Blackfoot River Bridge Board Sites. The red line indicates the 0.30 mg/L target.

Total Phosphorus

Phosphorus is also a nutrient that is listed as a pollutant of concern. The target for TP is 0.10 mg/L based on the EPA Gold Book Criteria (USEPA, 1987). The average concentrations for TP are summarized in Table 4. Four wadable sites either meet or exceed the 0.10 mg/L target. CC1 and SC1 sites either meeting the target or barely exceeding it. BrC1 and AC1 both exceed the target the most at 0.16 mg/L. None of the bridge board sites exceed the 0.10 mg/L target. A TP concentration for Rich bridge board site on 24 October 2001 was unusually high at 0.37 mg/L. Very little sediment was detected in this sample. The laboratory did a rerun and the concentration came back at 0.34 mg/L. IASCD and ISDA cannot explain the high particulate phosphorus concentration and concluded that this data point is an outlier and will be removed.

A good correlation between TSS and TP were found for five sites using simple regression, BR1 ($R^2 = 0.94$), SC1 ($R^2 = 0.91$), Indian ($R^2 = 0.88$), BrC1 ($R^2 = 0.71$) and

Govt ($R^2 = 0.71$). These correlations indicate that phosphorus (particulate form) is being mobilized along with sediment. The Morgan site showed a weaker correlation ($R^2 = 0.51$) and the Rich site showed no correlation ($R^2 = 0.047$). Rich may not have shown this relationship since it is greatly impacted by water from another source entering through the canal. DC1 site had insufficient data points ($n = 5$) to determine an accurate correlation.

The Permian Phosphoria Formation of southeastern Idaho is located in the upper subbasin (USGS, 2001). This is one of the largest phosphate deposits in the world and has been studied extensively by USGS. A large phosphorus mine is located within the head waters of Angus Creek. AC1 has one of the highest mean concentration of TP (Table 4). This could be a result of the active phosphorus mining in the upper reaches of Angus Creek or ground water flowing through the formation then surfacing.

TP concentrations peaked at the beginning of the sampling period in late July 2000 as seen in Figure 6a and 6b. Two of the sites, BrC1 and RC1, cattle were being turned into the range and were present at those sites. For WC1, CC1 and AC1, there are also elevated concentrations in late July 2000, there were no cattle present at the sites.

At the bridge board sites, TP concentrations were highest at Rich. The two highest concentrations occurred during April and October 2001 (Figure 6c). The high concentration in April corresponds to a high concentration of TSS on the same date. This could be a result of sediment and phosphorus being mobilized from spring runoff. The high concentration in October is what IASCD and ISDA determine to be an outlier since no sediment is moving with the phosphorus at this time. Ortho phosphorus remained non-detect on the bridge board sites.

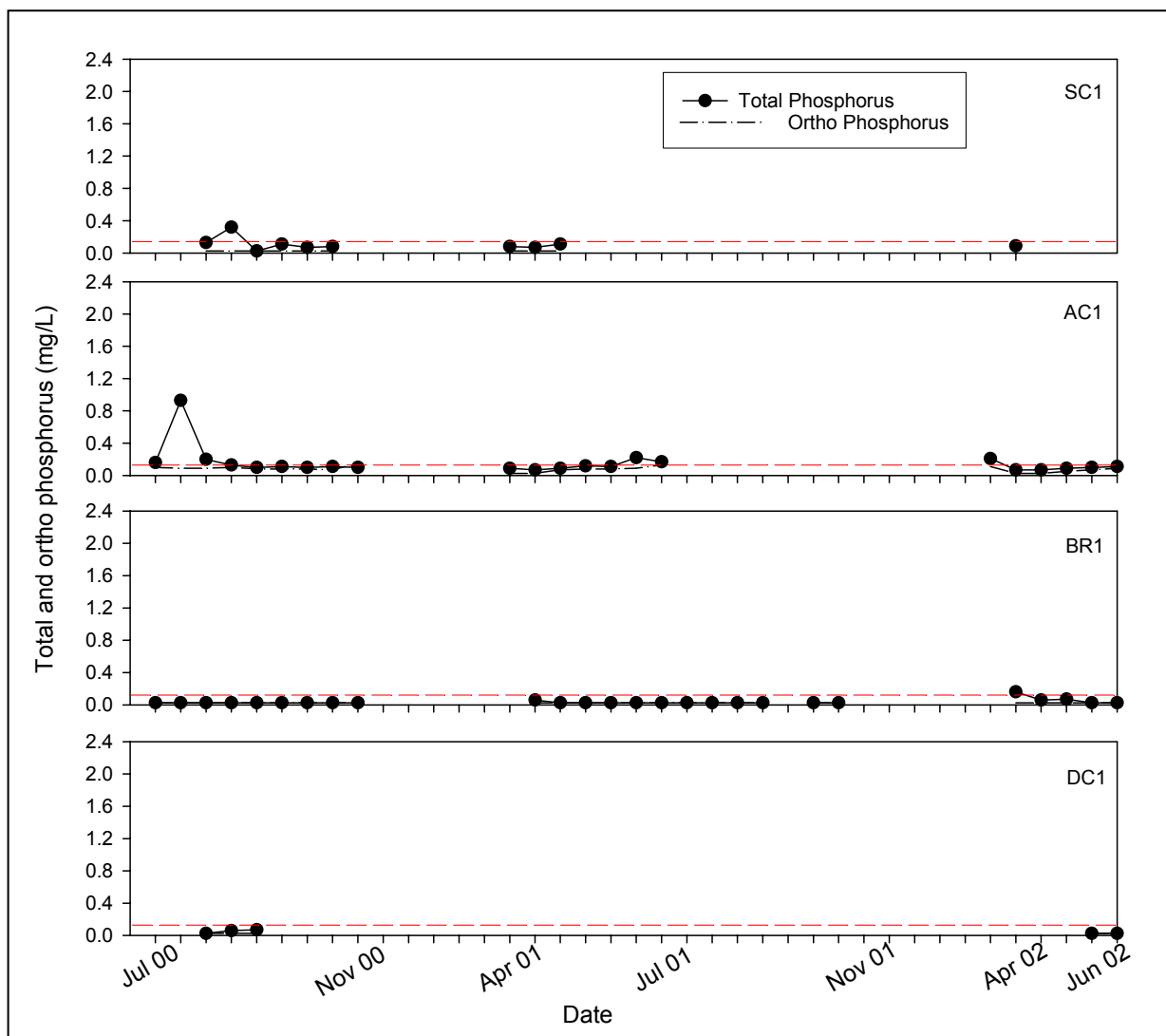


Figure 6a. Total and Ortho Phosphorus Concentrations for Wadable Sites above the Blackfoot Reservoir. The red line indicates the 0.10 mg/L target.

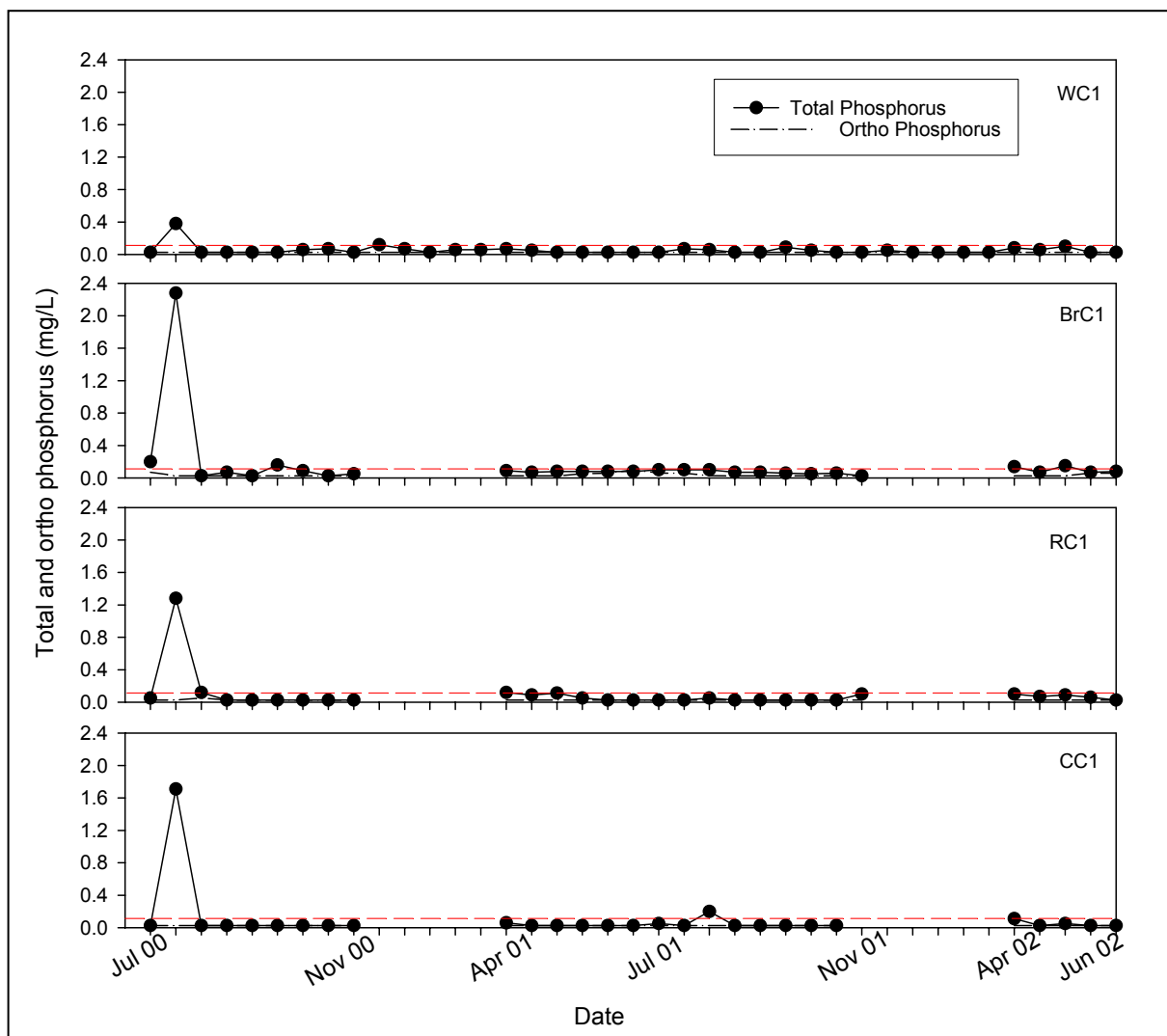


Figure 6b. Total and Ortho Phosphorus Concentrations for Wadable Sites below the Blackfoot Reservoir. The red line indicates the 0.10 mg/L target.

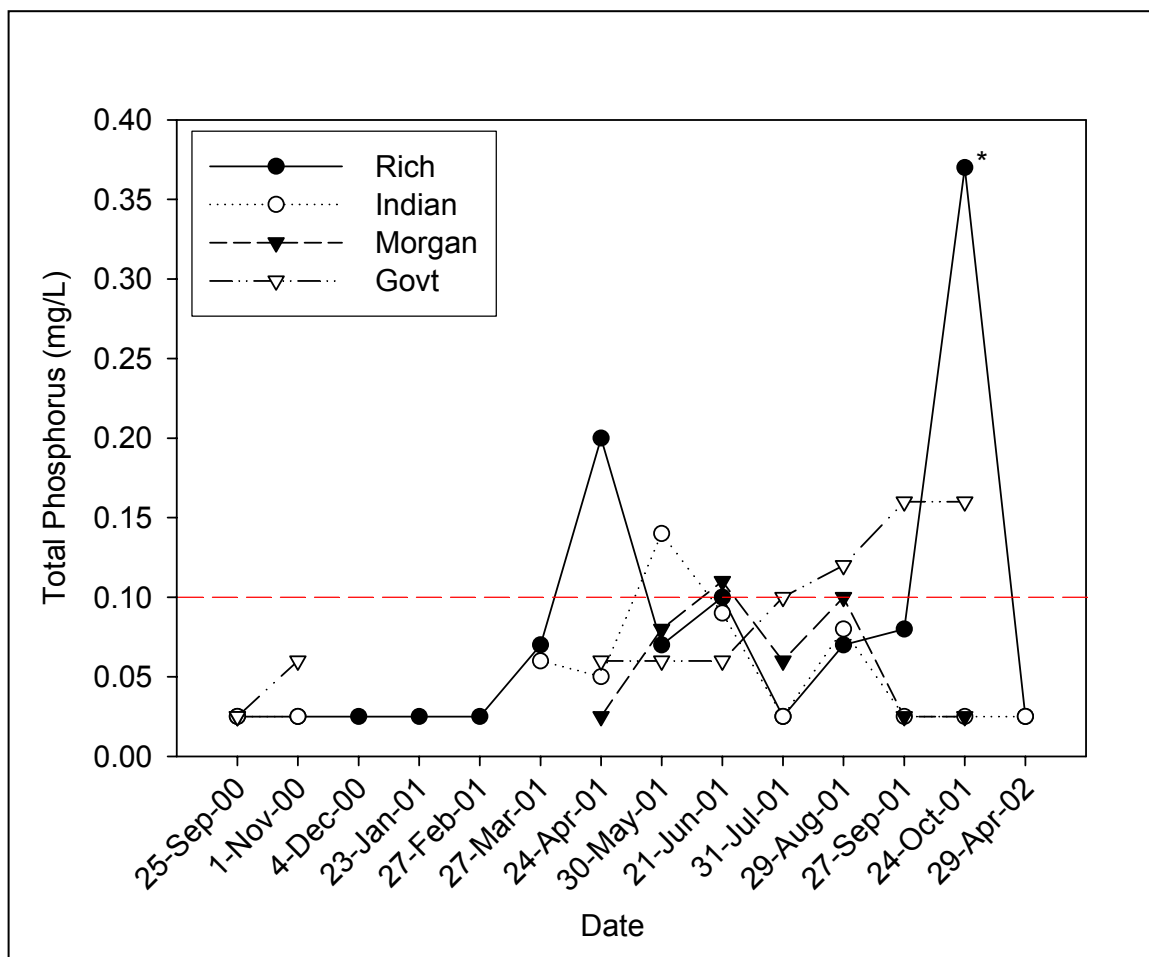


Figure 6c. Total Phosphorus Concentrations for Blackfoot River Bridge Board Sites. The red line indicates the 0.10 mg/L target.

*Possibly an outlier.

Bacteria

The *E. coli* standard for primary contact recreation is not to exceed 406 organisms/100 mL at any time and not to exceed 576 organisms/100 mL at any time for secondary contact recreation. PCR is defined in Rules of the Department of Environmental Quality, IDAPA 58.01.02, “Water Quality Standards and Wastewater Treatment Requirements” as “water quality appropriated for prolonged and intimate contact by humans or for recreational activities when the ingestion of small quantities of water is likely to occur.” Examples of PCR include, but are not restricted to, swimming or water skiing. SCR is defined by IDAPA as “water quality appropriate for recreational uses on or about the water.” These uses can include fishing, boating, wading or other activities where ingestion of raw water would not likely occur.

Tributaries and the river do not have bacteria listed as a pollutant of concern. However, the beneficial uses for the tributaries include SCR, and for the river, PRC is listed as a

beneficial use. *E. coli* counts in the subbasin remain relatively low. Several tributaries have a few exceedences of *E. coli* for PCR and SCR (Figures 7a and 7b). These exceedences occurred primarily during the summer months, July through September, when the water levels were low and the ambient air temperature was high. Low volume and high temperature increases the water temperature providing a good environment for bacteria to multiply. The bridge board sites do not exceed the standard for *E. coli* at any time during the sampling period (Figure 7c).

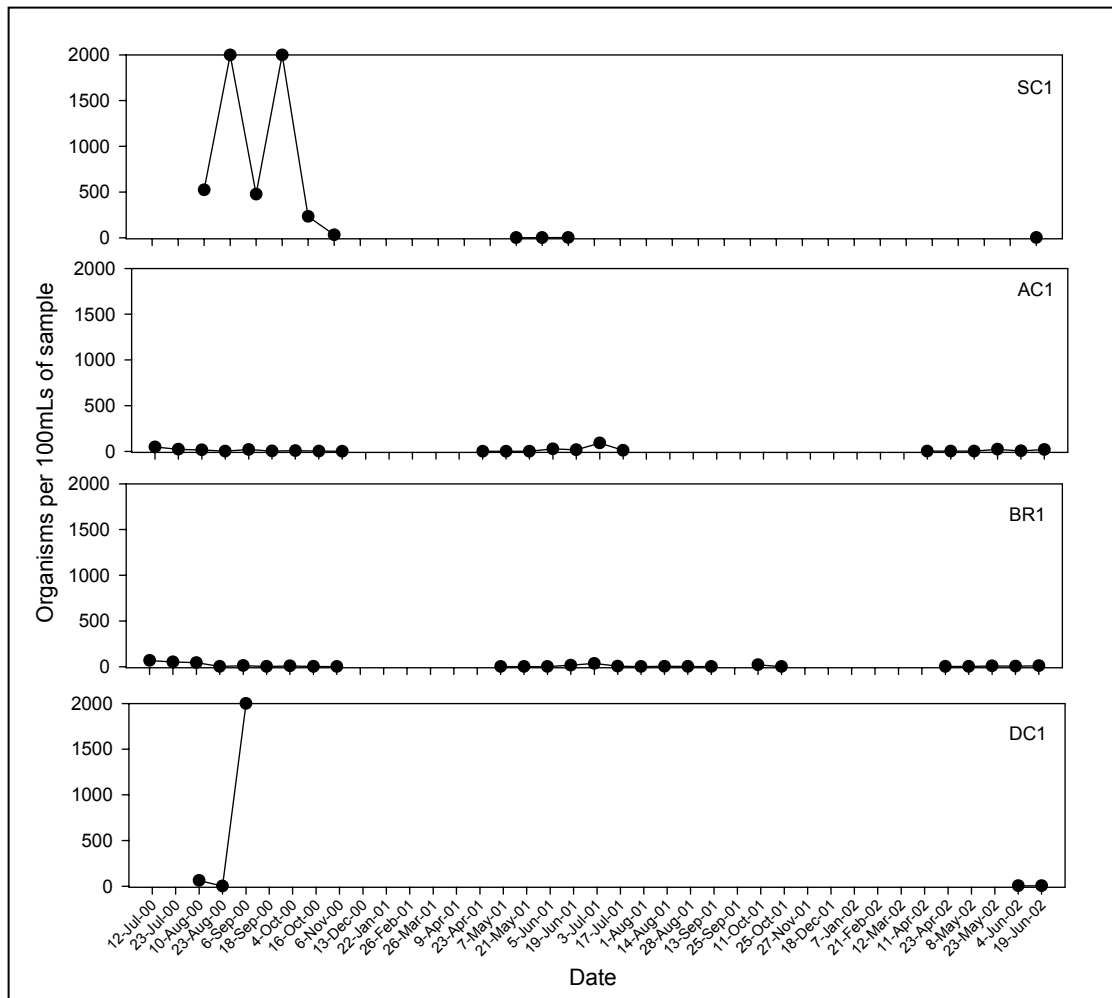


Figure 7a. *E. coli* Concentrations for Wadable Sites above the Blackfoot Reservoir.

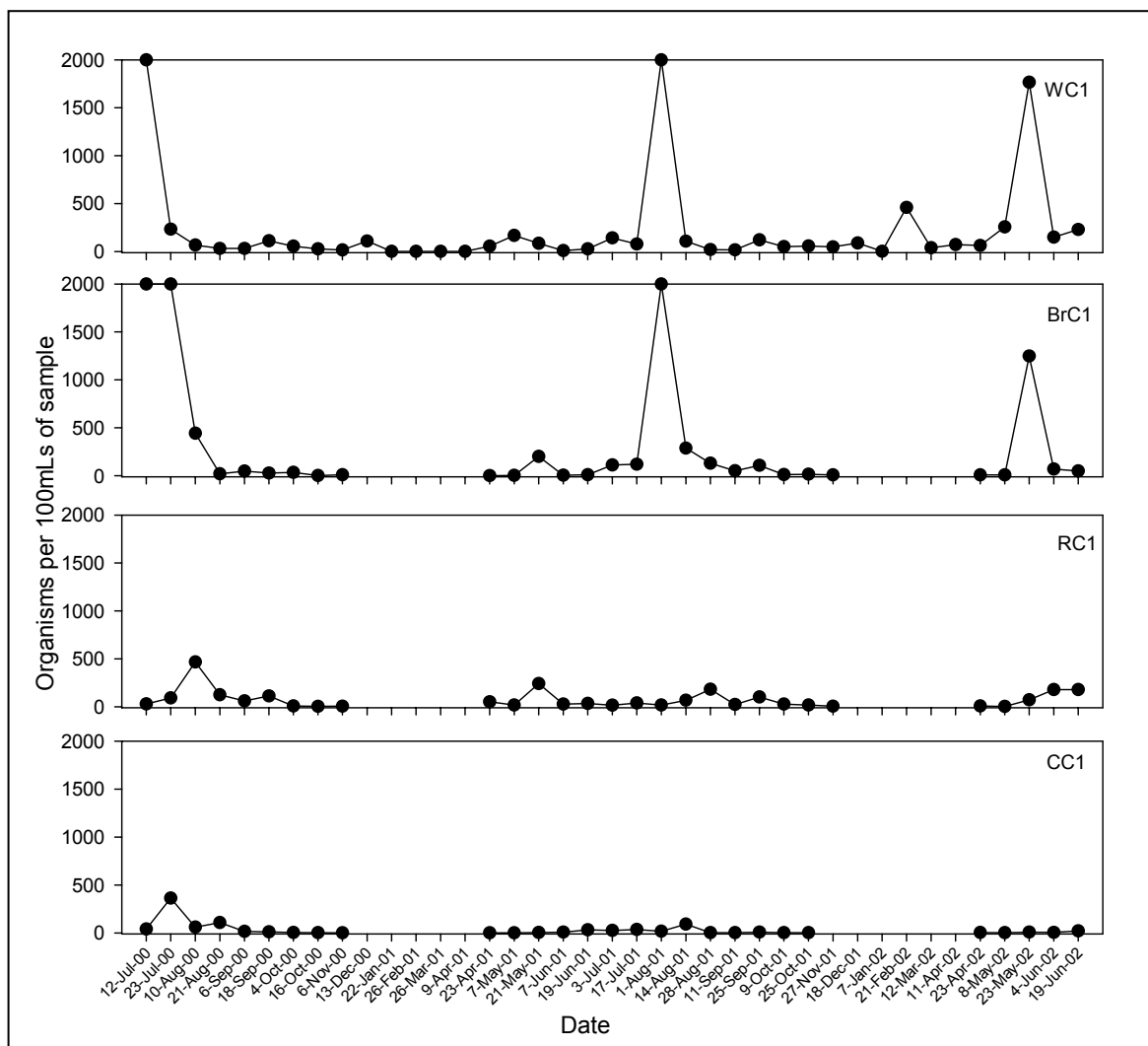


Figure 7b. *E. coli* Concentrations for Wadable Sites below the Blackfoot Reservoir.

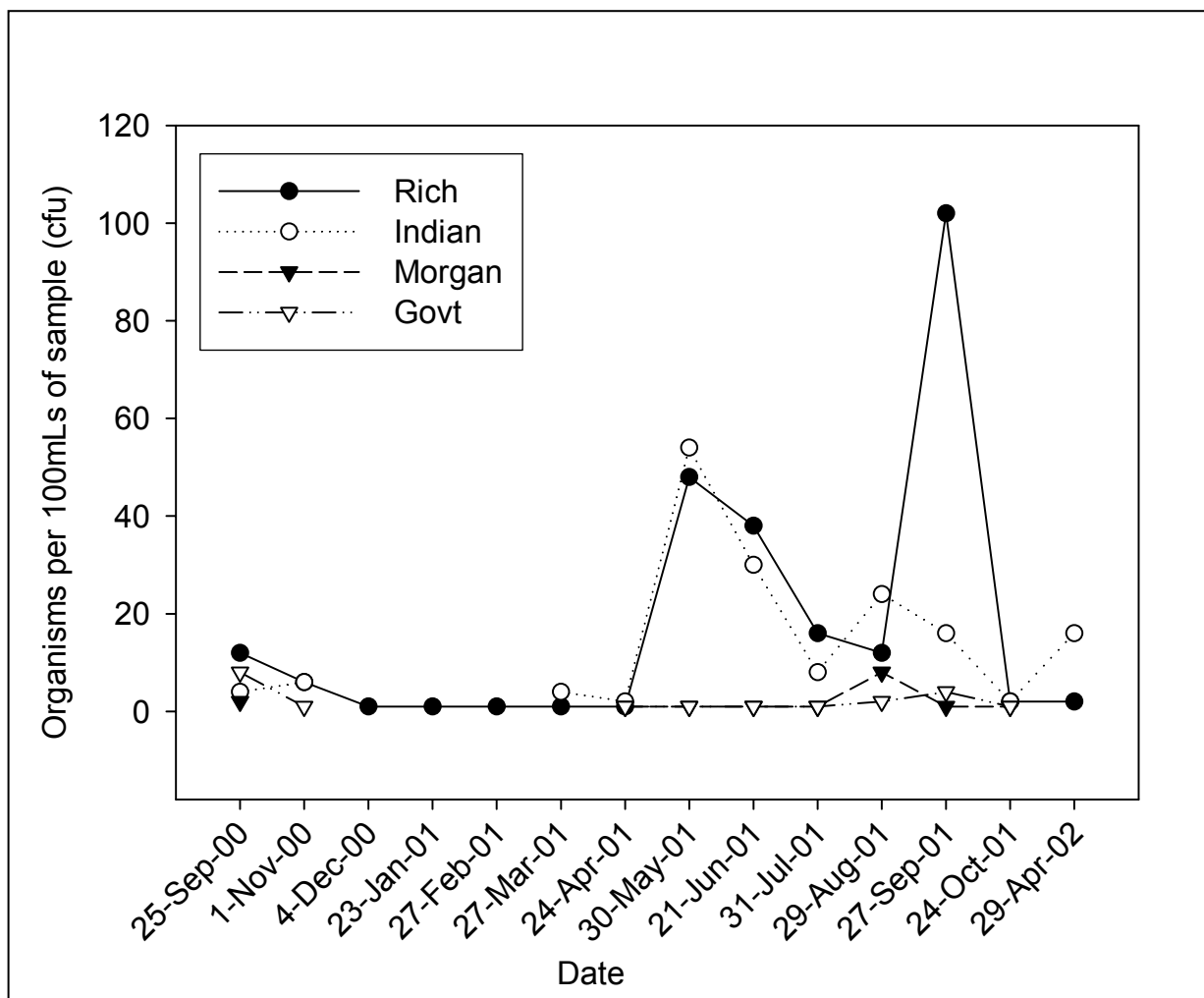


Figure 7c. *E. coli* Concentrations for Blackfoot River Bridge Board Sites.

For every exceedence on BrC1, cattle were observed on the stream banks. One bacteria exceedence for SC1 and DC1 also had cattle present along the stream banks. There are some sites, WC1, RC1 and CC1, where the standard was exceeded but cattle were not observed immediately near the site. However, WC1 mimics the BrC1 pattern for *E. coli* spikes as seen in Figure 7b. Cattle appear to be the primary source for *E. coli* when they are in the vicinity of a monitoring site.

Conclusions

Sediment appears to be mobilized during spring runoff or precipitation events. Peak concentrations of TSS occurred not only in the spring, but also in the fall when precipitation fell as rain or snow. BrC1 seems to have a couple of high TSS concentrations that would be the result of cattle grazing upstream of the monitoring site. On the Blackfoot River below the reservoir, the spike in sediment concentration appears

to enter the river through the Reservation Canal. The sediment may originate from the canal itself or transported through the canal.

The nutrients in the system may be naturally occurring. $\text{NO}_2 + \text{NO}_3$ concentrations are difficult to trace. It may come from precipitation, in the form of runoff and snowmelt. $\text{NO}_2 + \text{NO}_3$ concentrations may also come from decomposing organic matter, aquatic vegetation, or occur naturally through ground water.

TP tends to move with the sediment in BrC1, SC1, BR1, DC1, L. Indian, Morgan and Govt sites. There is also a large phosphorus formation, Permian Phosphoria Formation, located in the upper subbasin. This could result in the high concentrations of TP at the Angus Creek site. Ground water transporting TP may also influence stream concentrations.

There is a decrease in DO at Rich in late summer and early fall. When the lowest DO occurred, the highest concentration of TP was recorded as was a high concentration of $\text{NO}_2 + \text{NO}_3$. The decrease in DO occurred when the Reservation Canal water had been turned off to the Blackfoot River. Some bio-chemical impact occurred during the October of 2001 and IASCD is not sure what caused the dissolved oxygen sag.

At some site, bacteria counts for *E. coli* increased when cattle were present on the stream bank or in the stream. However, there were higher levels of *E. coli* at some sites, WC1, when cattle were not seen within the area. Other wildlife (deer, elk, waterfowl etc.) share the watershed and at times contribute to the bacteria load within the system.

Recommendations

Cattle seem to be an acute problem on the river and creeks in the subbasin. When they are present, there are higher concentrations of TSS, TP and *E. coli*. The cattle do not appear to remain directly on the stream for long periods of time. If water facilities were developed off stream, this would help reduce loads of TSS, TP and *E. coli* entering the river and creeks.

The Reservation Canal appears to be a problem for both TSS and TP. Levels for these two pollutants increase when the canal is first turned into the Blackfoot River between Little Indian and Rich Lane bridges. Perhaps ramping the water in the canal would decrease the immediate erosion and deposition of TSS and TP into the river.

The $\text{NO}_2 + \text{NO}_3$ levels will continue to be monitored through June 2003. It does not appear to be a large problem in the subbasin, but perhaps the source could be closer pinpointed. Levels increase during snowmelt events, which may indicate that it is naturally occurring.

Monitoring at Rich and L. Indian bridge board sites should continue during the late summer and fall months to determine if the low DO, in 2001, was a once time instance or it occurs yearly.

References

- IDEQ. Idaho Department of Environmental Quality. 1999. Portneuf River TMDL: Waterbody Assessment and Total Maximum Daily Load. Idaho Department of Environment Quality, Pocatello, Idaho.
- IDEQ. Idaho Department of Environmental Quality. 2001. Blackfoot River TMDL: Waterbody Assessment and Total Maximum Daily Load. Idaho Department of Environment Quality, Pocatello, Idaho.
- Miller, S. 1998. Selection of a Total Suspended Sediment (TSS) Target Concentration for the Lower Boise River TMDL. CH2M HILL, Boise, Idaho.
- USEPA. U.S. Environmental Protection Agency. 1987. Quality Criteria for Water. EPA Publication 440/5-86-001. U.S. Gov. Printing Office, Washington D.C.
- Scully, Dick. 2002. Personal communication. Regional Fisheries Manager, Idaho State Department of Fish and Game. Pocatello, Idaho.
- Shelton, L.R. 1994. Field Guide for Collecting and Processing Stream-Water Samples for the National Water-Quality Assessment Program. U.S. Department of Interior, USGS. <http://water.wr.usgs.gov/pnsp/pest.rep/sw-t.html>.
- USGS. U.S. Geological Survey. 2001. Mineralogical characterization of strata of the Meade Peak Phosphatic Shale Member of the Permian Phosphoria Formation. Open-File Report 02-125. U.S. Department of Interior, USGS, Denver, Colorado.
- USGS. U.S. Geological Survey. Internet. Water Resources of Idaho, Idaho NWIS-W Data Retrieval, <http://waterdata.usgs.gov/nwis-w/ID>, 23 August 2002.
- Wetzel, R.G. 1983. Limnology, second edition. Saunders College Publishing, New York, New York.

Appendix A

Quality Control Results

Quality Assurance/Quality Control (QA/QC)

The QA/QC procedure for this monitoring program conformed to those outlined in the “Water Quality Sampling Plan”, prepared by the IASCD.

Intermountain Analytical Services- EnviroChem utilized EPA approved and validated methods. Method performance evaluations include quality control samples analyzed with a batch to ensure sample data integrity. Internal laboratory spikes and duplicates are all part of EnviroChem’s quality assurance program.

Field QA/QC protocols consisted of duplicate samples and blank samples. The field blanks consisted of laboratory grade deionized water, transported to the field, and poured off into properly prepared sample containers. For filtered constituents, deionized water was transferred into the filtration unit, filtered, and the resultant filtrate was transferred into appropriate sample containers. The blank samples were used to determine the integrity of the field teams sampling handling, the cleanliness of the sample containers, and the accuracy of the laboratory methods. There were no constituents detected (above the method detection limits) for any of the blank samples submitted during this program.

With the exception of samples for bacteria analyses, the duplicate samples consisted of two sets of sample containers filled (in the field) with the same composite water from the same sampling site. All of the duplicate samples were collected from the same location (Wolverine Creek) July 2000 through June 2001. Samples for bacteriological testing were collected by filling two separate sterile sample containers directly from the source. The duplicate samples were not identified as such and entered the laboratory as blind duplicates. The duplicate samples were used to determine both field and laboratory precision. All of the QC samples were stored on ice and handled with the normal sample load for shipment to the laboratory.

Table 6. Duplicate Comparison, Mean and Standard Deviation

Parameters	WC1 Mean	Duplicate Mean	WC1 Standard Deviation	Duplicate Standard Deviation
TSS	30.3	30.5	23.4	23.3
TVS	2.97	2.95	1.97	1.95
Nitrate+Nitrite	0.25	0.25	0.40	0.40
Total Phosphorus	0.05	0.05	0.06	0.06
Ortho-Phosphorus	0.03	0.03	0	0

Precision

Relative percent difference (RPD) is the normal measure of precision when calculated from duplicate sample. As previously mentioned, the duplicates were collected in the field. The calculation for RPD is as follows:

$$RPD = \frac{(C_1 - C_2) * 100\%}{(C_1 + C_2) / 2}$$

Where: RPD = relative percent difference
 C_1 = Larger of the two observed values
 C_2 = Smaller of the two observed values

Table 7. Relative Percent Differences (duplicates)

Date	WC1 NO ₂ +NO ₃	Duplicate NO ₂ +NO ₃	RPD	WC1 TSS	Duplicate TSS	RPD	WC1 TVS	Duplicate TVS	RPD
7/13/00	0.025	0.025	0	7	3	80	1	1	0
7/23/00	0.025	0.025	0	9	3	0	1	1	0
8/10/00	0.025	0.025	0	9	3	0	1	1	0
8/21/00	0.025	0.025	0	9	2	40	1	1	0
9/6/00	0.025	0.025	0	4	3	28.6	1	1	0
9/20/00	0.025	0.025	0	24	13	59.5	5	5	0
10/4/00	0.025	0.025	0	13	12	8	3	2	40
10/18/00	0.025	0.025	0	27	37	31.2	4	5	22.2
11/8/00	0.025	0.025	0	9	11	20	2	2	0
12/13/00	0.75	0.75	0	93	85	9	8	8	0
1/22/01	0.83	0.79	4.94	55	53	3.7	5	5	0
2/26/01	0.025	0.025	0	41	38	7.6	4	3	28.6
3/27/01	0.025	0.025	0	68	68	0	4	4	0
4/9/01	0.025	0.025	0	52	54	3.8	4	5	22.2
4/25/01	0.025	0.025	0	52	53	1.9	4	4	0
5/9/01	0.025	0.025	0	31	34	9.2	3	3	0
5/21/01	0.025	0.025	0	32	32	0	3	3	0
6/7/01	0.025	0.025	0	7	5	33.3	1	1	0
6/19/01	0.025	0.025	0	8	8	0	1	1	0
7/3/01	0.025	0.025	0	3	4	28.6	1	1	0
7/16/01	0.025	0.025	0	4	4	0	1	1	0
8/1/01	0.025	0.025	0	46	50	8.3	5	5	0
8/13/01	0.025	0.025	0	10	11	9.5	1	1	0
8/30/01	0.025	0.025	0	13	16	20.7	2	3	40
9/11/01	0.025	0.025	0	18	19	5.4	2	2	0
9/25/01	0.025	0.025	0	33	34	3	3	3	0
10/9/01	0.025	0.025	0	34	39	13.7	1	1	0
10/25/01	0.025	0.025	0	19	19	0	3	3	0
11/27/01	1.13	1.12	0.89	35	35	0	2	2	0
12/18/01	1.08	1.07	0.93	19	26	31.1	1	1	0
1/7/02	1.1	1.1	0	46	48	4.3	3	3	0
2/21/02	0.025	0.025	0	38	37	2.7	4	4	0
3/12/02	0.75	0.75	0	46	44	4.4	4	4	0
4/11/02	0.025	0.025	0	51	49	4	6	4	40
4/23/02	0.81	0.81	0	92	94	2.2	9	9	0
5/8/02	1.02	1.02	0	53	53	0	4	4	0
5/23/02	0.85	0.85	0	42	44	4.7	4	4	0
6/4/02	0.83	0.84	1.20	31	30	3.3	3	3	0
6/19/02	0.025	0.025	0	18	18	0	1	1	0

Table 7. Continued

Date	WC1 TP	Duplicate TP	RPD	WC1 OP	Duplicate OP	RPD
7/13/00	0.025	0.025	0	0.025	0.025	0
7/23/00	0.38	0.4	5.13	0.025	0.025	0
8/10/00	0.025	0.025	0	0.025	0.025	0
8/21/00	0.025	0.025	0	0.025	0.025	0
9/6/00	0.025	0.025	0	0.025	0.025	0
9/20/00	0.025	0.025	0	0.025	0.025	0
10/4/00	0.06	0.025	82.4	0.025	0.025	0
10/18/00	0.07	0.07	0	0.025	0.025	0
11/8/00	0.025	0.025	0	0.025	0.025	0
12/13/00	0.12	0.12	0	0.025	0.025	0
1/22/01	0.07	0.08	13.3	0.025	0.025	0
2/26/01	0.025	0.025	0	0.025	0.025	0
3/27/01	0.06	0.06	0	0.025	0.025	0
4/9/01	0.06	0.05	18.2			
4/25/01	0.07	0.07	0	0.025	0.025	0
5/9/01	0.05	0.06	18.2	0.025	0.025	0
5/21/01	0.025	0.025	0	0.025	0.025	0
6/7/01	0.025	0.025	0	0.025	0.025	0
6/19/01	0.025	0.025	0	0.025	0.025	0
7/3/01	0.025	0.025	0	0.025	0.025	0
7/16/01	0.025	0.025	0	0.025	0.025	0
8/1/01	0.07	0.08	13.3	0.025	0.025	0
8/13/01	0.06	0.05	18.2	0.025	0.025	0
8/30/01	0.025	0.025	0	0.025	0.025	0
9/11/01	0.025	0.025	0	0.025	0.025	0
9/25/01	0.09	0.09	0	0.025	0.025	0
10/9/01	0.05	0.05	0	0.025	0.025	0
10/25/01	0.025	0.025	0	0.025	0.025	0
11/27/01	0.025	0.025	0	0.025	0.025	0
12/18/01	0.05	0.05	0	0.025	0.025	0
1/7/02	0.025	0.025	0	0.025	0.025	0
2/21/02	0.025	0.025	0	0.025	0.025	0
3/12/02	0.025	0.025	0	0.025	0.025	0
4/11/02	0.025	0.025	0	0.025	0.025	0
4/23/02	0.08	0.1	22.2	0.025	0.025	0
5/8/02	0.06	0.06	0	0.025	0.025	0
5/23/02	0.1	0.1	0	0.025	0.025	0
6/4/02	0.025	0.025	0	0.025	0.025	0
6/19/02	0.025	0.025	0	0.025	0.025	0